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ECA/SDA/IRD/89/1.1(ii)(b)

ROLE OF TECHNOLOGY IN SMALL FARMERS' PRODUCTIVITY IN AFRICA

LC/NAIROB

UNITED NATIONS
ECONOMIC COMMISSION FOR AFRICA

ECA/SDA/IRD/89/1.1(i)(b)

ECONOMIC COMMISSION FOR AFRICA
Joint ECA/FAO Agriculture Division

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Addis Ababa,
July 1989

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SUMMARY

The rural areas of Africa are the home of over 70 per cent of its population, of which a majority is made up of small farmers. Despite their numbers, they have suffered neglect and their productivity in relation to their potential is low. To regain food self-sufficiency, the small farmers' productivity needs to be increased, especially in light of increasing population pressures and a decreasing food self-sufficiency ratio in the region.

One way to increase productivity is to use new and improved technologies on the farms. These technologies and techniques are already in use on a limited scale and need to become more widespread in the region. The technologies in use on small farms often leave much scope for improvement and thus even a relatively minor change can make a significant difference in productivity. The most important characteristics of the technologies suitable to small farmers in Africa are /sustainability, maintainability, low cost, and social acceptability./ The paper examines technologies which satisfy these criteria. Furthermore, some techniques, such as alley cropping, are discussed which could increase productivity without the need for the introduction of technologies from outside.

The widespread adoption of low-cost, sustainable and locally produced technologies is seen as a necessary first step towards higher productivity. As higher productivity is achieved, the farmer will be able to afford more sophisticated but adapted equipment. Not only will his or her productivity be increased, but the rural areas will become a more attractive place to live and work, especially for youths and men, who tend to want to seek their fortunes in the urban areas, leaving behind the women to tend the fields. Since it is the women who perform the largest part of farm work, technologies must be geared toward them if they are to have the most impact.

Governments need to formulate coherent policies with regard to appropriate technologies to be used on small farms, as well as pricing policies which will give the farmers an

incentive to try to increase their production. Past failures have shown that the introduction of mechanized equipment is not the solution to this problem, and it is for this reason that a step-by-step approach to the introduction of suitable technologies is advocated.

INTRODUCTION

1. The key to the development of Africa lies in the development of its rural sector. The rural areas are the home for 70-80 per cent of the population of the region. It has been widely recognized and accepted that the region cannot progress with its development without the strengthening of agricultural production to achieve at least sustainable food self-sufficiency. Without this self-sufficiency, Africa will stay overly dependent on outside assistance, costing it not only valuable financial resources but also its dignity if not sovereignty. It is a sad fact that the present trend in the region is towards a lower food self-sufficiency ratio than in previous decades. This is due to a high population growth rate, coupled with methods of food production which are not always optimal in relation to the potential of the land. It is well established that one of the major causes of the poor performance of Africa's agricultural sector has been and unfortunately remains the neglect of the sector by national policy makers. The basic problem facing Africa today is how to feed its growing population with the available resources. Compared to Asia, Africa has a much lower population density and thus much more land is in theory available for cultivation of food crops. In practice, land in Asia is cultivated more intensively, and with a higher degree of technical resources.

2. Furthermore, part of the land suitable for food crops in Africa is taken up by cash crops, and much of the food is, therefore, grown on marginal land which cannot sustain prolonged cultivation. During times when population pressures were not as great as in the latter half of the twentieth century, African farmers were able to practise shifting cultivation, moving from one plot of land to another to let it rest and recover its productivity. For this purpose, more and more land was cleared, and plots could lie fallow for some time, even years, before being reused. Nowadays, due to the lack of easily accessible and suitable land in many parts of the region, it has become increasingly difficult to find new land to practise shifting cultivation.

Often the new land is only marginally suited to growing food crops, and it is also frequently cleared at the expense of valuable resources, such as forests. This marginal land is often further away from vital resources such as water and fuelwood, making its cultivation more time-consuming and laborious.

3. One way of alleviating and even overcoming the problems of food crop production in Africa is to introduce appropriate technologies of a kind which would enable the African small farmer to increase his or her productivity without having to resort to the destruction of forests or to trying to cultivate marginal land. This technology should also be within the farmer's means and should be easily maintainable and suitable to the prevailing conditions on the farm. Small farmers form the backbone of food production in Africa, but it is these small farmers who are the most neglected when it comes to allocating resources. One must not overlook the vital role these farmers play in feeding the continent. Without them, the urban populations would soon be without food except through importations. Therefore, it is necessary to focus on these small farmers if one is to achieve progress in developing the region. It is too often the case that countries place more emphasis on the production and export of cash crops, as it is these crops which have been traditionally earning foreign exchange for the economy.

4. In fact, the Lagos Plan of Action recognizes the crucial role which technology has to play in the development of Africa's agriculture. It states, inter-alia, that "attention should be paid to the role of science and technology in integrated rural development. This would require, among other things, the generation of financial resources and political will and courage on the part of policy and decision makers of the continent to induce profound change with far-reaching effects on the use of science and technology as the basis of socio-economic development as a matter of the utmost importance and urgency at this fateful juncture in history." 1/

OBJECTIVES OF THE STUDY

5. This study attempts to give an overview of technologies and techniques which already are in use and could be put to

more widespread use on small farms in Africa. It also endeavours to indicate how these could play a role in improving the productivity of small farmers. Emphasis is placed on simple, or so-called "intermediate" technologies, and also on technologies which can be produced indigenously or with the least possible amount of foreign inputs. The sustainability, maintainability and ease of operation of the technologies was always kept in mind when chosing examples.

6. The study also attempts to show that significant gains in productivity are possible by using largely indigenous technologies and techniques which require no or only minimal outside inputs. The use of such technologies is to be seen as the first necessary step towards higher productivity, which would then enable a farmer to invest in more sophisticated but adapted technologies if required.

RELEVANCE OF THE STUDY

7. The economic base of the development of the rural sector of Africa is generally agriculture which is largely substistence oriented. Cereal is its pre-eminent subsector. The producers of food in Africa are mostly small farmers, majority of whom are women. Simple hand implements (hoes, axes and machetes) symbolize their traditional technology and low productivity. Hence, agriculture, having settled down to a low level of equilibrium of income savings and investment, started stagnating. The consequences of its stagnation was dramatically and cruelly brought to the focus by the starvation death of over a million people in the early eighties.

8. It is now widely recognized that the main path to Africa's socio-economic recovery and transformation lies in the increased productivity of its agriculture and attaining food self-sufficiency. 2/ There has to be a transition from hand hoes to more efficient technology if the productivity potential of African agriculture is to be realized. FAO's study "Agriculture: Towards 2000" shows that 60 per cent of the anticipated increases in farm production has to come from higher productivity and the rest from extension of acreage and greater intensity of cropping by raising the productivity. At the initial stage the emphasis has to be on the small farmers, whose preoccupation is survival. For, in

terms of acreage, output share of the rural population, generation of employment and poverty alleviation the role of small farmers is critical. Hence, this study concentrates on discussion of the types of technology which are considered appropriate to the small farmers.

METHODOLOGY AND LIMITATIONS OF THE STUDY

9. The basis of this paper, which is the outcome of a desk study, is information compiled from numerous publications dealing with rural technology, both from the United Nations and other sources, with an emphasis on the conditions in Africa. Generalizations had to be made due to the lack of specific material from various member States. It is hoped that the examples given are representative of the situation of the region as a whole.

10. The study does not purport to cover all types of technology which may be relevant to African farmers, but an attempt has been made to include those which seemed to have the most impact on small farmers, as these are the focus of the paper. In the selection process, which necessarily had to be carried out, certain types of technology were left out altogether or only mentioned in passing. These include technologies dealing with house construction, clothing, household items, infrastructure (roads, etc.), foundries and blacksmiths. Large-scale and capital-intensive technologies are also not included. Motor-driven technologies such as tractors were considered only marginally relevant to most African small farmers especially due to the history of failures of motorized implements in Africa.

11. As the study is concerned with small farmers in Africa, many technologies were considered both beyond the scope of this paper and beyond the means of the small farmer to obtain them. This, of course, imposes a limit on the types of technology which are discussed here, generally small scale and simple rather than large scale and capital intensive.

12. The study is also of course limited by the fact that due to budgetary constraints no field work could be undertaken to supplement the information obtained from existing publications.

DEFINITION OF A SMALL FARMER

13. The definition of a small farmer can vary from country to country and depending on the type of land he is cultivating. Since this paper is concerned with Africa, one can include farmers who are cultivating a total area of up to 5 ha. of land, which would be a big farm by Asian standards, for example, where a small farmer would be someone cultivating a plot of land of 0.5 ha. Also a smaller plot of irrigated land could be considered as equivalent to a larger plot of unirrigated land which has roughly the same productivity. In Africa, a farmer is often a woman, and this should be kept in mind even if the male pronouns are used to describe them.

14. In the African context, a farmer cultivating land up to 2 ha. in size is considered a small farmer, though the technologies used by someone with land up to 5 ha. in size would often not differ much from those in use on a smaller farm. A small farm is most often run by a family engaged in subsistence farming and uses labour-intensive methods. The difference between a farm of approximately 2 ha. and one of up to 5 ha. is often that the bigger one uses animal power for certain operations.

15. A small farmer with 2-3 ha. needs to use at least 60-70 per cent of his land to grow food crops to feed himself and his family, assuming yields of 1 tonne per ha. of cereals. Further characteristics of small farmers are "low and unreliable yields, unimproved species, low use of fertilizer or animal fodder, and limited pest and disease measures." 3/ Furthermore, a small farmer's low productivity leaves him very little capital with which he could take the risk of acquiring new technologies.

DEFINITION OF APPROPRIATE TECHNOLOGY

16. A survey of the relevant literature shows that there is a general agreement on what constitutes appropriate technology for farmers in developing countries. 4/ Appropriate technology is often defined as having the following characteristics:

(i) low in capital cost;
(ii) labour intensive rather than capital intensive;

(iii) use locally available material as much as possible;
(iv) should use local labour and skills and create jobs;
(v) should be affordable by the beneficiaries, i.e. small farmers;
(vi) need a low level of skill to operate, be able to be operated, controlled and maintained by local population;
(vii) can be produced by a small metalworking shop or in village itself;
(viii) must be compatible with local values, attitudes and preferences;
(ix) be subject to high degree of control and initiative by users;
(x) be flexible to suit changing circumstances;
(xi) facilitates the involvement of the beneficiaries; and
(xii) be amenable to dispersal and have a demonstration effect.

17. In general, it is necessary that the people who are meant to profit from the technologies have a say in its development and application. Furthermore, the United Nations Industrial Development Organization (UNIDO) states that "technologies evaluated for appropriateness are either already in use or new. With regard to technologies in use, the objective should be to improve their efficiency and productivity without transforming their basic characteristics. Then the transition to more efficient technologies would be easier. With regard to new technologies, each technology must be assessed to determine its suitability and acceptability in the context of the local factor conditions and circumstances." 5/ It must also be emphasized that a technology which is suited for one community may not be suited for another community with a similar problem to solve, because of differences in their approach to the particular problem. One must avoid imposing modes of behaviour on the people which are alien to them. Neither should new technologies cause a drop in productivity below the level that normally would have been attained with traditional technologies.

18. The technical knowledge of local people started to be taken more into account, according to McCall, for a number of reasons, such as the failures of many technical

interventions by development agencies, the rise of "appropriate technology" approaches since Schumacher's trend-setting ideas became accepted, the International Labour Organization's (ILO) basic needs approach, the experiences of the Non-governmental Organizations (NGO) working at the grass-root levels, and the discussions on local level development promoted by the United Nations Centre for Regional Development. 6/

TYPES OF TECHNOLOGY

Hand Tools

19. There are various types of hand-held tools in use on small farms in Africa. The most common implement is the hand hoe, which can be found throughout the region. It is usually the only tool used to till the fields and is suitable for many different types of soil. 7/ The hand hoe is often used by women and working with one entails a lot of bending and stooping. This back-breaking work could be alleviated by the introduction of hoes with longer handles, especially since hoes with longer handles and heavier heads can dig deeper into the soil. However, besides the problem of greater weight which has to be wielded, another problem encountered with longer handles is due to the fact that the fields often are not cleared of tree stumps and other obstacles. These obstacles have often prevented the farmer from executing the wider swinging motion which is necessary to use a hoe with a long handle. 8/ The logical solution would be to clear the fields of obstacles, but this would require work which in many cases require much time and/or technology beyond the individual farmers' means. The above is an example of how a solution to a problem may seem obvious at first, but then turns out to be less desirable when applied in actual field conditions.

20. Another hand tool which is widely used is the knife. It is used for cutting crops at harvest time and also to clear land before cultivating. This is also back-breaking work, and scythes and sickles would seem to be the obvious solution to this problem. However, scythes and sickles, despite their advantages in efficiency and speed of work, are often too heavy for the farmers who use them, mainly women, and are disliked also because they can cause injury. 9/

21. Planting and weeding also generally involve stooping and bending, but there are technologies which can alleviate these arduous tasks. There are low-cost, hand-operated seed planters which can be made locally, and would make the task of planting less burdensome and more efficient. Weeding is also one of the most labour-intensive tasks on a small farm, but simple weeders are available which can increase the efficiency of the operation and thus the area which can be weeded. 10/

22. The exclusive use of traditional hand tools imposes numerous restrictions on the farmer, such as the size of land he can expect to work on within the given technological, temporal and also meteorological constraints. The use of hand tools usually means that the farmer is working at subsistence level. However, "because of the primitive nature of many traditional implements, much scope exists for increasing labour productivity by improved hand tools and man-powered machines." 11/

23. To give an idea of how hand-held implements dominate over other technologies such as animal and motor-driven technologies, some statistical examples from a few member States might be useful. In Sierra Leone, for example, over 80 per cent of farm technology consists of simple hand tools. In Ghana the figure is 85 per cent, and in Uganda the figure is even higher, close to 90 per cent. 12/

24. Another problem area is the quality of locally produced hand tools. They are often made of scrap iron, as no other source of raw materials is available for local blacksmiths and in general the quality is not of a high standard. Tools of a higher quality are usually expensive and not readily available. Thus, there is a need for the improvement of the quality of locally manufactured tools to provide farmers with better equipment.

Human-powered Technologies for Crop Processing and Other Tasks

25. Besides the hand-held tools, there are a number of human-powered devices which either already are in use or which could potentially increase the productivity of small farmers, if only by saving them time and labour. In this

category fall devices such as threshing and winnowing machines, grinding mills, oil presses, corn crushers, maize shellers, groundnut decorticators, cassava graters, etc. All of them have a low initial cost and high local material content in common and are easily available from the development workers connected with research institutes.

26. After a long day of working in the field or carrying heavy loads on their backs, women often spend their time grinding crops such as maize, rice, sorghum and millet. This is a tedious task, even more so after a long day's work. The degree of exhausting labour involved can be ascertained from the fact that it can take one to two hours of grinding to produce enough flour for the evening meal for one family. It is possible to alleviate this problem by purchasing a small community mill at a price which is within the means of the community. These hand-operated mills are capable of an output of about 15 to 20 kgs of flour per hour, which means that a week's supply for one family can be produced in about half an hour, a significant improvement over the traditional method of making flour. 13/

27. Not only hand-operated mills are available, also pedal-operated and animal-powered mills can be found. In East Africa, maize is often not ground into flour but only crushed, and there are small low-cost machines which can do this job more efficiently than the traditional method. There are many other types of simple and affordable machines which can make the processing of crops easier. Some examples are hand-operated oil presses which are used to extract oil from oil palm fruit, coconuts, groundnuts, caster seeds and simsim. There is also a simple apparatus which decorticates groundnuts, thus reducing the effort needed by a significant degree.

28. Some equipment, which may be beyond the means of a single farmer to build or purchase, could be purchased by a community as a whole and shared among the families. This would enable the acquisition of better equipment, which would in turn reduce the time and labour needed to process the crops. This saving in time and energy can be put to use in other areas, such as non-farm income-generating activities.

29. Another form of processing involves drying the crop in order to preserve it for later use, thus also preventing the loss of a part of the produce. Solar drying would enable the farmer to preserve vegetables for consumption outside the harvesting season. This method has the advantage of being very low cost, since the dryers can be made out of mud, wood and other available materials. There are economic and health advantages to this method too. The farmer is not forced to sell his surplus produce in a short time after harvest before it starts to rot, and can have a supply of food, for the rest of the year, which would give him and his family a more balanced diet, as well as be available for sale. 14/

Crop Storage

30. Post-harvest food losses are a serious problem for small farmers in Africa. Up to half the harvest can be lost due to poor and inadequate storage of a crop. The traditional storage methods can be easily improved on at low cost in order to lower the post-harvest food losses due to rodents, insect pests, and mould or rotting due to dampness. 15/ The simplest improvement to the traditional storage cribs is to raise them above the ground by at least about one metre. This prevents rats from jumping into them, as these animals can jump as high as 80 centimetres. Also, the storage cribs would need to be placed away from any protrusion or elevation from which a rat could reach the crib. The legs supporting the crib should be fitted with baffles made of thorns or metal in order to prevent animals from climbing up into the crib. Another methods of preventing the intrusion of rodents is to install traps around the storage cribs.

31. Insect pests present the most dangerous threat to stored crops. Pyrethum, which can be obtained locally, is an example of an insecticide which involves a minimum of outside inputs. 16/ Insect-proofing can be achieved by coating the outside of the crib, which is usually woven basket-work, with mud and cow dung. Insects can be prevented from entering the storage crib by filling and sealing the walls tightly. In Zambia, cribs plastered with dried mud inside and out are used to store maize kernels. 17/ However, it must be ensured that the grain is free of insects before it is placed inside the crib. To prevent

insects from entering the crib as passengers on the crops, it is advisable to dry the crop in a solar dryer before putting it in the storage crib. The heat kills or expels any insects which might be amongst the crop as they are not able to withstand the temperatures generated inside the dryer. Drying the crop also prevents the accumulation of moisture which could destroy it by creating favourable conditions for moulding and rotting.

32. In Nigeria, where the "estimated losses are as high as 20 per cent for maize" 18/ In parts of the humid south, different methods of storage have evolved depending on the climatic conditions. The storage methods used in Nigeria are described as follows by O.A. Koleoso and O.O. Onyekwere: "Maize in the south is too wet to store after harvest. The problem is to get the moisture down to 14 per cent, the recommended level for bag storage. An ingenious method of drying is used in the south. The farmer stores the maize in a crib, which is a rectangular basket-like shed with legs made of bamboo. The bottom of the crib is made of palm leaves and sides are of palm fronds woven into a basket. It has a thatched roof made of overlapping grass leaves. Maize cobs with the husks removed are carefully stacked and dried by air blowing through the corn layers. The maize nearest the outside dries first to about a 14 per cent moisture level and protects those in the centre from infestation and mould. The bamboo legs prevent the entry of rodents. This ingenious drying method costs the farmer next to nothing. When required for sale, the maize is removed, shelled and bagged. The difference in northern Nigeria is that the maize is harvested when already pretty dry. Husked maize is stored in mud huts built up to prevent rodents entering and is shelled and bagged depending on market demand... In co-operative farms and government-sponsored organizations, insecticides have been used on the cribs... The drawback in this respect is that the maize cannot be consumed for at least three months, and that some insects become resistant to the insecticides." 19/

33. As can be seen from the above examples, there is sufficient indigenous know-how on crop storage, as well as simple and easily replicable improvements which can be applied in order to reduce post-harvest food losses.

Productivity could be raised considerably if these improvements were applied on a larger scale.

Animal Traction

34. The use of animal traction is much less widespread in Africa than the use of hand-held implements, often being used on less than 5 to 10 per cent of a country's farmed land, though more farmers practice animal husbandry than use animals to do farm work. Animal traction in most cases means the use of oxen to pull ploughs and other implements. Despite its great potential in increasing the productivity of the small farmer in Africa, it is a technology which remains under-utilized. The principal reasons for its relatively low level of utilization are the lack of traditions of animal husbandry in many parts of the region, and also the prevalence of diseases which kill cattle in sub-Saharan Africa.

35. The most common draught animal is the oxen. Its advantages are that it is hardy, strong, easy to feed, works slowly but steadily, needs no complicated harness and yoke, and can be sold for meat. The disadvantages include the difficulty of training it, the need for large grazing areas and its relatively slow speed of work. 20/ Donkeys are also hardy beasts of burden, but their small size limits the range of uses they can be put to.

36. The battle against trypanosomiasis is being fought on various fronts. The cheapest and most environmentally sound method is to catch the tsetse flies which spread the disease with low-cost traps, in which they are left to die. This method shows promise, especially if it can be spread over a wide enough area. Another approach is to vaccinate the animals or to spray pesticides on tsetse-infested areas. "Since 1978, both the Food and Agriculture Organization (FAO) and the International Livestock Centre for Africa (ILCA) have begun studies on cattle varieties resistant to trypanosomiasis. The ndama cattle of far western Africa and the muturu of coastal western Africa appear to have natural resistance, but are smaller than the usual African zebu breeds. However, crosses between the zebu size and the muturu exist in both Nigeria and Benin which combine zebu size with natural resistance. Improving and spreading these

resistant breeds would seem a safer way forward than massive spraying of chemicals, the long-term effects of which are little known in Africa." 21/ Despite these measures, trypanosomiasis remains a major impediment to the widespread introduction of the cattle. In some cases the introduction of draught oxen failed because they succumbed to trypanosomiasis, one solution was for the farmers to pool their resources and hire machinery such as tractors to sustain the desired level of productivity.

37. Another problem encountered with the introduction of animal power is that in many parts of Africa, there is no tradition of animal ownership and care, and that it is therefore "extremely difficult to instil in /the farmers/ the necessary management skills and sympathy that the use of animals demands. These are very often the areas where the animal health problems are greatest so that introduction will not necessarily produce the hoped for advantages." 22/

38. Attempts to improve on traditional animal-drawn implements, such as ploughs have sometimes failed miserably. ILCA developed a one-ox plough for use in Ethiopia. It was based on the Ethiopian maresha plough, which is normally pulled by two oxen, and was initially designed to overcome the shortage of oxen in the country. While the one-ox plough worked well during trials, it did not meet with the farmers' approval when used under actual field conditions. The reasons for the failure are described as follows: "... The ox had to trail the new plough at the end of a flexible rope harness. This was different from the two-ox yoke, which is fixed fairly rigidly to the plough. With the rigid coupling, the farmer can exert weight on the plough to steer the team of oxen... Also, when one ox stumbles, it can steady itself against the other. With the one-ox arrangement, there was no rigid coupling, so the farmer had to lug the plough himself. On the one-ox plough, a skid regulated the depth of ploughing. The skid broke easily and farmers could not fix it themselves... In future, ... before scientists go to work to ease the plight of the peasant farmers, they would do well first to ask the farmer a few questions". 23/

39. Despite the above-mentioned problems, animal power represents the economically best solution to the increase of

productivity of the small farmers in the region. A pair of oxen can work significantly more land in a given time than hand tools. Animals are cheaper than machinery to purchase and operate, and do not need spare parts and costly fuels. Neither do machines reproduce on their own accord. The fields of small farmers are often irregular in shape and have obstacles such as tree strumps in them which would make the use of machinery impractical. Dust and dirt are other impediments to the smooth running of machinery which do not affect draught animals very much. The efficiency of an animal is, of course, dependent on how well-nourished it is and on the design of the equipment it is pulling.

40. Although animal power is slowly gaining ground in countries such as Nigeria and Zimbabwe, hand-tool technology still dominates in most countries, especially in the Sahel zone. 24/ On balance, "the advantages of work animals are that they can offer a relatively low-cost, low-energy, self-supporting, reproducible... and potentially comprehensive system of appropriate mechanization... The main disadvantages of animal-power based technology are that it requires animal-husbandry skills which are not always in evidence, and animals and equipment remain expensive for the average smallholder..." 25/ as well as the prevalence of diseases which kill animals, such as trypanosomiasis. However, animal power probably still represents the mose economically viable and socially acceptable means of achieving higher productivity for small farmers in Africa.

Motor-driven Machinery

41. Motor powered machinery is still a rarity on small farms in Africa. Despite the various types of machinery which potentially are suitable for African conditions, experience with farm machinery such as tractors has shown a very low success rate. In Uganda, for example, only 0.01 per cent of the farmers have tractors. 26/

42. The reasons for this general failure are numerous but not difficult to appreciate. First, the price of machinery is generally beyond the financial means of a small farmer. In an attempt at modernization, African countries introduced tractors without fully taking into account the prevailing conditions on their farms. Any alternative scheme which did

not involve "modern" machinery came to be seen as backward, and the result was much waste of resources and abandoned tractors.

43. The reason why tractors were abandoned lies in the fact that spare parts are difficult and costly to obtain, and that the machinery was not used and maintained properly, often due to lack of skilled mechanics. The more parts a machine has, the more they are likely to fail. Furthermore, the fuel needed to run the machinery might not always be available, or too expensive, meaning that the machinery will lie idle for a long period.

44. Machinery which seems to be suitable for small farmers has been developed, such as small one-axle tractors, but "in the main, it is not possible to scale engine-powered technology down to the level where it is technically or financially suited to the individual smallholder." 27/ Engine-powered machinery in general is expensive, not produced locally and requires fossil fuels and constant skilled maintenance to work to optimum level. Small, fuel-efficient and robust machines have been designed and manufactured, but might not be easily accepted as a "real" tractor.

45. A further constraint on the introduction of motor-driven machinery is its potentially adverse social impact. Machinery generally becomes the domain of men who tend to apply it to cash crops rather than food crops, which leads to an alienation of the women who are relegated to the more tedious jobs and thus do not benefit from the introduction of machinery. 28/

46. There are examples which show that tractors are not indispensable and can be replaced by other means. "For instance, the classic argument about the tractor is that the ground is so hard after the dry season that only a tractor will break it quickly enough to allow planting, the timing of which is absolutely critical to within a few days. The obvious answer to this is to change slightly the pattern of agriculture so as to avoid the need for a tractor. Our agricultural people, who have worked in East Africa for a long time, tell us that this has been done and is being done on increasing scale. You do not, in fact, turn under or

clear away the rubbish lying on the ground immediately after the harvest. The answer is to run duck's-foot tines through the soil, just breaking up the first few inches of the soil and leaving all the rubbish on top. The rubbish becomes part of the humus and the ground is already broken up. There is no need for tractors provided one approaches the system intelligently. In addition, the equipment is very simple and can be made locally." 29/ In this context, it must be noted that the rubbish must be disposed in a manner which would prevent it from becoming a habitat for insect pests which could remain until the following planting season.

47. Capital-intensive machinery does not seem to be the immediate answer to the question of how to increase a small farmer's productivity, due to the constraints outlined above. On a limited scale, machinery of this type can play a role, especially if farmers are able to pool their resources to, say, hire rather than buy tractors when they are needed. Cheap technologies such as diesel-powered reapers which are carried on the back could speed up the harvesting of crops if they could be made available, and above all, be maintainable over a long period of time. The problem of sustainability under the prevailing conditions has to be taken into account, and it is for this reason that alternatives to engine-driven machinery seem to be more suitable to small farmers in Africa at the present stage of development.

Cropping and Fertilizing Methods

48. Though methods of cropping may not be considered technologies per se, they do play an important role in raising the productivity of small farmers. Yield-raising chemical fertilizers are usually beyond the financial means of a small farmer, and, therefore, methods of natural fertilization such as mulching need to be applied on a wider scale. Improvements in cropping and natural fertilization methods could raise yields without the need for more capital-intensive technologies. This would also eliminate dependence on outside sources and thus prove to be more sustainable and acceptable.

49. The traditional form of growing crops in Africa is known as intercropping. In contrast to the Western practice, this involves planting different types of crops on the same field and not necessarily in rows. Unfortunately, this practice was in the past condemned as not modern and thus was not given the attention due to it by the relevant research institutes and universities which dealt with improving yields. As the emphasis was placed on cash crops, the food crops were neglected, strengthening the impression that what was being done by the small farmers was both irrelevant to the nation's economy and backward. Luckily for the small farmer in present-day Africa, it has been recognized that intercropping offers numerous advantages over the Western system, particularly in the African context.

50. "Research over the past decade has confirmed that the peasants had it right all along. Intercropping is superior to monocropping in the African environment." 30/ It was found that intercropping was not simply an adaptation to time, labour and technology limitations, but "a considered response to the environment." 31/ The reasons for the superiority of intercropping are numerous: soil and water conservation, lowered risk due to availability of at least one crop if the others should fail, nitrogen fixation, reduction of pests because insect pests receive confused pheromonic signals from a mixture of crops, increased food security, better exploitation of soil nutrients and moisture, better utilization of available land, creation of a protective microclimate and better distribution of labour. 32/

51. Another advantage arises when both cash crops and food crops are combined in one field. On African farms, there is generally a division of labour between men and women, with some crops, usually cash crops, belonging to the men and food crops being the women's responsibility. It is generally the women's duty to weed the fields. Thus, if cash crops and food crops are combined in one field, the women would weed both types of crop, potentially raising the yields of both the cash and food crops. Furthermore, the women could claim rights to part of the income gained from the cash crops which otherwise would be completely controlled by the men, thus earning some extra income which can be invested in attempts to further improve the farm or the standard of

living though normally it is the men who control the income generated by cash crops.

52. Examples of intensive intercropping can be found in various parts of Africa, notably East Africa and Nigeria. "In northern Nigeria as many as 156 separate crop combinations have been observed. The Konso people of south eastern Ethiopia regularly cultivate 49 different plants, shrubs and trees. In a single small Konso field of 0.2 ha., 24 different species were counted, including sorghum, maize, barley, millet, amaranth, tobacco, coffee, cotton, pigeon pea, kidney beans, lima, castor and hyacinth beans, taro, yam, cassava, safflower, linseed, red pepper, tree gourd, and moringa, a tree whose leaves are boiled as vegetables." 33/

53. Given the advantages of intercropping in Africa, it is necessary to develop varieties of crops which give the highest, and above all, stablest yields when planted among other crops. A high yielding cereal crop which causes a decline in yields of a tuber it is intercropped with will not be readily accepted by a small farmer. High-yield varieties of various crops, particularly cereals, have done well in research laboratories, but their practical application under harsh farm conditions has often presented a different picture. High-yield varieties usually need chemical fertilizers to give the desired results, but these fertilizers may be inaccessible to small farmers. Furthermore, the seeds of these hybrid varieties need to be obtained from outside every year. Pest and disease resistance may also be lower than with traditional varieties, cancelling out any advantage gained by a higher yield per hectare. Therefore, it is more desireable to have varieties which produce viable seeds and have high resistance to pests and disease, even if their yield is not as high as the best hybrids. Stable yields at the lowest possible risk and cost in a typical African farm environment is the goal to be aimed at. Research is needed to find the optimal combination of crops which gives the highest overall yield, and also reduces the incidence of pests. The fact that intercropping reduces the uncertainties and risks which an African small farmer constantly faces is a significant reason for promoting this type of farming.

54. Agroforestry, which combines forestry and agricultural methods, is a promising way to make use of the natural ability of trees to conserve and improve the environment in which crops grow. Farmers need to actively plant trees in a planned way, rather than relying on trees which grow wild. Tree planting has already been promoted in various countries, notably Kenya. In the context of agroforestry, a variation on intercropping called alley cropping would be a means of increasing the productivity and fertility of the ground. Alley cropping involves planting rows of trees between the crops. These trees should be fast growing and nitrogen fixing. Besides the multiple uses a tree has for farmers, the main advantages of this form of cropping are that the leaves can be used as mulch to fertilize the soil without the farmer having to provide costly chemical fertilizer, and thus increases yields. The most suitable tree for this type of cropping seems to be Leucaena leucocephala, which "grows fast, even on marginal soils, and provides high quality fodder, mulch and firewood." 34/

55. Alley cropping allows a piece of land to be cultivated without having to intersperse fallow periods, because there is always enough natural fertilizer available to allow continuous growing of crops. The planting of trees takes up some land, but the increase in yield gained by their presence makes up for the loss of a small portion of the field. It is not costly, but can be labour-intensive to establish. The gains are apparent after one or two years, and the system does not cost anything after it has been set up. No special skills are needed to start alley cropping, and it is easy to learn. The farmer needs to know that the trees have to pruned and the cuttings left on the ground as mulch to provide nutrients to the food crop. More research into alley cropping needs to be done, and it needs to attain wider dissemination, but it seems to provide a viable solution to the problem of how to increase productivity without requiring the farmer to use scarce capital for fertilizer and other inputs. 35/

56. Chemical fertilizers also need a certain amount of knowledge on the part of the farmer as to the proper type of fertilizer to use, the optimal dosage and the correct amount of water to be applied in order to ensure its effectiveness. This knowledge may not be available and could lead to

mistakes being made, as well as increasing dependence on outside assistance in applying the fertilizer. Furthermore, the long-term effects of applying chemicals need to be studied in order to avoid any possible medical problems resulting from their use. Chemical fertilizers might give better results, but again, are often not within the financial means of a small farmer.

57. Mulching is a way of fertilizing one's fields without resorting to expensive chemical fertilizers. Population pressures have forced African farmers to cut down on fallow periods and thus deprive the soil of the time needed to regenerate. For this reason, the need for fertilization has grown more acute. Also, the fact that more manure is used as fuel rather than as fertilizer has also contributed to the lower rate of fertility of the soil. The only low-cost alternative to the lack of land and capital to buy chemical fertilizers is to spread the stalks and other debris from plants on the fields to turn into mulch, which provides much-needed natural fertilization to the soil. As land becomes more and more scarce, and more and more marginal land is used for farming, the traditional pattern of shifting cultivation is disappearing, and alternatives have to be sought. The first steps towards increasing the productivity through improved and sustainable fertility lie in practices such as mulching, alley cropping and intercropping. Not only do these methods increase productivity, they also prevent soil erosion, which is another problem facing small farmers in Africa.

Water

58. In order to improve productivity, better access to water is necessary not only to improve the irrigation of the land, but also to reduce the time and labour spent in obtaining it. The obtention of water and its effective and efficient use is one area which has great potential for improvement in Africa. Most small farmers depend on rain to water their fields, and irrigation systems for small-scale farms are a rarity in Africa, compared to other regions of the world. More efficient means of collecting water, be it rainwater, groundwater or surface water are needed. Furthermore, water collection is a chore which consumes a large amount of time and energy which could be used more effectively. In most

cases, it is the women who collect water, and often they have to travel very long distances to reach the place where it can be obtained. Since it is also the women who generally have to do the largest portion of farm work, this means that they have less time and energy for their other chores in the fields and at home. As more and more marginal land is taken over by small farmers as a result of population pressures, the distances which need to be travelled to fetch water tend to increase. This is analogous to the problems encountered in fuelwood collection.

59. One means of alleviating the burden on the women is to dig wells and install water pumps and other water-lifting devices, either in or near the villages, or if that is not feasible, one can install devices near the water-gathering points to make the lifting of water easier. The main consideration would again have to be the simplicity and mechanical reliability, low cost and low maintenance requirements of the pump and its adaptation to the social requirements of the people concerned. Various designs are available, such as the chain-and-washer pump and hydraulic ram pumps. 36/ If a farmer is not able to afford one himself, the village could pool its resources to obtain one or even build one itself at low cost if the material and technical skills are available. Alternatively, it could be financed by a donor agency. These pumps should be locally-made and to the greatest extent possible be made out of locally available materials, though some materials might not be available in the immediate vicinity of the village and might have to be provided from further away. After the pump has been installed, its maintenance and operation should be in the hands of the users themselves. This gives them a sense of responsibility towards the equipment and also a sense of ownership, and avoids giving them a feeling of being dependent on outsiders.

60. Another cheap and efficient means of ensuring a more regular supply of water is to construct and set up large jars in which to store rainwater collected from roofs. 37/ This would also help in reducing the time and energy spent on collecting water. It is necessary to construct a large jar with a capacity around 3,000 litres out of cement into which water from roofs can run when it rains. The cost of

constructing such cement jars is very low, and they are feasible even in areas with low rainfall. To improve catchment, it is practical to cover a thatched roof with plastic sheeting, or, if possible and affordable, to have a galvanized tin roof, though this is not a necessity. Furthermore, these jars are not difficult to produce and are much cheaper than containers made of other materials, such as metal.

61. It is a fact that most fields in Africa are rain-fed, and that larger-scale irrigation schemes have not been successful in providing regular supplies of water to farmers. Egypt, Morocco and the Sudan are among the few countries in Africa which have tried large-scale irrigation schemes, but in most countries there have been setbacks due to lack of maintenance, increased salt and water saturation of the soil, displacement of people and lack of trained personnel to design the schemes. 38/ This is not to say that irrigation is not feasible in Africa, but it needs to be approached on a smaller scale and in a way that is more suitable to the conditions encountered. Africa has numerous rivers which give it a potential for irrigation, but these have remained largely untapped. Small-scale irrigation schemes and techniques which are very basic do exist, such as shadoofs, small earth and stone dykes and wells lined with logs which can be set up cheaply by the farmers themselves.

62. Other techniques to catch rainwater include stone lines, water catchment basins and grassed strips, which are arranged in such a way as to follow the contours of the land and, thus, prevent the water from running off uselessly. These simple techniques can mean the difference between being able to grow a number of crops and having to abandon the land. 39/

Transport Technologies

63. In many parts of Africa, it is common to see women carrying heavy loads, often water or firewood. If a way to alleviate their burden could be found, it would have to be suited to the kinds of paths the women have to traverse.

64. Simple and cheap wheelbarrows have been developed which would seem to be a suitable solution to the problem of transporting smaller loads. However, they have not gained widespread acceptance because:

(a) the women are more used to carrying a load than pushing or pulling, which can also be tedious, and

(b) the terrain which has to be negotiated often makes a wheelbarrow unsuitable for the task. 40/

65. One solution would be to employ animals such as donkeys to do the carrying, but these animals might not always be available or affordable. The bullock cart which is common in Asia has not caught on in Africa, partly because of the prevalence of trypanosomiasis, as mentioned earlier, and partly because of the lack of animal husbandry skills. If it could be introduced on a wider scale in the region, it would provide a low-cost means of transporting goods to market without the need of engine-driven vehicles. Often, roads are of poor quality and repair, and a bullock cart is better suited to negotiate them than a motorized vehicle.

Fuelwood and Other Energy Sources

66. Wood remains the main energy source for 90 per cent of the African population, 41/ despite its increasing scarcity and the great efforts involved in gathering it. Even in Nigeria, which is rich in petroleum, 80 per cent of the energy is supplied by wood. 42/ The seemingly unstoppable trend toward deforestation and the depletion of wood resources has made it increasingly difficult and time consuming for small farmers to collect fuelwood, and often they have had to turn to alternative sources of fuel such as cow dung.

67. The gathering of fuelwood in Africa is traditionally carried out by women and is generally perceived as one of her household tasks, especially since the wood is usually free of charge. This might not be a major cause for concern if the wood were available in abundance close to home, but this is rarely the case in rural Africa. The result is that women spend much energy in collecting and carrying it home, as well as time which could be applied more usefully to farm

chores. The productivity of the farm could be increased if the source of fuel were more readily available.

68. It is at present not conceivable that wood and its derivate charcoal can be replaced on a large scale by other sources of energy, whether renewable or not. The main obstacles are the high cost of other energy sources, and their general unavailability. The only alternative to wood which is readily available, at least in those parts of Africa which have livestock, is cow dung. Cow dung burns with more smoke and needs more tending than wood fires, but more importantly, it deprives the soil of a valuable source of natural fertilizer, contributing to the degradation of the farmers' very source of livelihood.

69. The situation is well described by "one of the few studies of energy use in a non-electrified village in Africa (Bara, Kordofan Province, Sudan, with a population of 10,050) with a per capita kerosene consumption of 17 kg/a almost four times the national average. The study shows that time for gathering firewood has increased from 15-30 minutes to 1-2 hours in the last decade, with the result that women are finding it increasingly impactical to collect their own wood. Instead, peasants who have lost their land to the desert now gather firewood for sale, and because of the labour-intensive nature of wood gathering, at harvest time the price of wood increases by 25 per cent and charcoal prices by 66 per cent. In the last decade (1970s) the price of charcoal has increased threefold mainly due to deforestation. Three-quarters of the households which purchase charcoal use it only in lamps while the other quarter also has Primus stoves. Charcoal is used most extensively in cooking, but also for space heating, melting soap and ironing. The charcoal is burned in stoves or heaters made from petrol cans. Finally, desertification, soil erosion and drought are increasingly serious problems. The population is beginning to cut gum arabic trees for firewood rather than market their sap, and definite declines in the standard of living are being experienced by the poorer majority of villagers." 43/

70. To break out of this vicious circle, the simplest measure would be to plant more trees closer to or on the farm itself. Alley cropping would be the ideal technique to

apply in order to ensure a steady supply of wood for many uses, not merely as fuel. However, even such simple-sounding solutions have to face various problems, such as those given below.

71. The problem of fuelwood gathering is often not perceived as a priority which needs to be addressed urgently for the following reasons:

(a) Other problems such as food production and water collection are more pressing;

(b) The wood is usually available free of charge;

(c) Fuelwood collection is seen as part of a woman's household chores;

(d) Lack of wood is often considered an individual problem, not the problem of the community as a whole. 44/

Another problem which appears when land is to be allocated for tree growing is that the village chiefs might be reluctant to give away land for long-term programmes of this kind and thus lose some of their power to parcel out land on a short-term basis. 45/

72. The most useful approach to the problem would be to plant multi-use trees such as Acacia albida and Leucaena leucocephala, which not only provide fuelwood, but also timber, fertilizer and shade. Another approach has been the attempt to introduce more efficient cooking stoves in an attempt to cut down the amount of wood or charcoal needed to cook a given amount of food. This unfortunately is not a straightforward exchange of an inferior apparatus for a better device. First of all, a new stove usually costs more than the traditional one, but its advantage over the long term may not be perceptible if its fuel efficiency is not markedly higher than that of the previous model. The new stoves might be more labour-intensive if they require the fuelwood to be chopped into smaller pieces before use. Also, a new stove might not be able to serve as a means of lighting the dwelling, forcing the family to light a separate fire, which in turn cancels out any economic gains made by using a fuel-efficient stove. Lastly, the

introduction of more sophisticated stoves from outside might bypass the traditional village artisans who had been making the previous model. 46/ The above are some of the factors which need to be taken into account when attempting to introduce improved cooking stoves.

73. Burning wood is not an efficient way of obtaining energy, but it is still the cheapest and most readily available means of producing heat on rural Africa. Kerosene would be an alternative, but its high cost and the problems of transporting it to remote rural areas do not make it a viable option at present. Another alternative which is very inexpensive to use is solar energy. The problems encountered with solar cookers, however, have made it clear that they are not acceptable. The reason for this is mainly that to use a solar cooker the family would have to change its pattern of life to adjust to this apparatus. A simple solar cooker which concentrates the sun's rays on one point, creating enough heat to boil water, needs to be constantly adjusted to the sun's position. Also, the number of pots which can be attached to it is limited to one, so very little food can be cooked at one time. In rural Africa, the evening meal is often the most important, and it is thus impossible to use the solar cooker at this time of the day. For women who are used to cooking indoors, moving outdoors to perform this vital activity may also be undesirable. There are more advanced solar cookers available which overcome some of the above problems, but they are costly and need more sophisticated installation procedures. 47/

74. The use of biogas is potentially the most promising alternative to fuelwood, as the example of China has shown. In Africa, the practice is not yet widespread, because it faces various obstacles. One problem is that the use of biogas is more efficient when it is stored in large quantities, which would mean the sharing of one energy source by a number of households, either at a communal cooking place or by piping leading to each home. Both alternatives pose problems, as communal cooking might not be a desirable alternative, and because piping could prove quite costly. 48/ Another restriction is that livestock rearing and agriculture are often separate activities in Africa, making difficult the access to the manure needed to keep a biogas fermenter operating. Biogas would have the

best chances of catching on in the parts of Africa which support livestock and agriculture on the same farm, as is the case in East Africa. 49/

75. The introduction of alternative sources of energy is often not successful due to the high initial costs involved. Even if a donor can be found to alleviate this problem, there are often insurmountable social obstacles to the acceptance of an alternative to the traditional burning of wood for energy. The productivity of small farmers can, at this stage, only be increased if they have easier access to wood, leaving them more time for other farm chores. This means that above all more trees need to be planted. The emphasis needs to be placed on multi-purpose trees, which would be the beginning of the integration of agroforestry with crop farming. Trees are needed not only to provide fuelwood, but also to prevent soil degradation and erosion, as well as to provide vital mulch, wood for tools and construction, shade, fodder for animals and even food for human consumption. Trees will continue to play an absolutely vital role in the development of rural Africa and must be given the highest priority. Hence, agro-forestry seems to be the most viable solution to the energy crisis and can be applied on a larger scale than the other options, particularly since fuelwood will remain Africa's primary source of energy.

SOCIO-ECONOMIC ASPECTS OF TECHNOLOGY

76. Technology can be the solution to many of mankind's problems, but it is rarely introduced without some form of social change to accompany it. This is no less true in the context of small farmers in Africa. Technology of a certain type, namely "appropriate" or "intermediate" technology is nowadays often seen as the panacea to the problems facing African farmers. To what degree this is true will to a great extent depend on the acceptability of the technology in the society it is supposed to bring benefits to.

77. The use of improved technology has a direct relation to improvements in the standard of living of the people who use it. Better technology, no matter how simple it may seem, saves times and provides them the opportunity to enjoy higher yields and thus the potential to make a profit on the

extra which they do not need for their own consumption. A higher profit in turn means that more money is available for everyday items which make life easier, and also for the schooling of the children. Higher yields also mean that more food is available for the family and that malnutrition can be avoided. All these factors add up to a happier, more content family which also is healthier than one which does not have the benefits of better technology and techniques. This is not to say that technology is the only factor in an improved standard of living, but it does constitute an important aspect in the solution to the problem of how to improve the productivity and quality of life of a small farmer in Africa.

78. Furthermore, if some of the extra money earned through higher productivity is given to the women, it is often the case that they will use it for the purchase of useful items and to set up small business on the side in order to have the chance to improve their incomes even further. It is often the case that new technologies are demonstrated to the men of a village or farming area, while the women who actually do the work for which these technologies are designed are not present at the demonstration. It is unfortunately often the assumption that it is the men who are always the ones to work the fields, while generally the opposite is true. It is mostly the women in Africa who grow the food crops, and it is they who need to have access to the new technologies. The women need to be involved in the process of dissemination, testing and adoption of technologies which seem to hold the promise of improving productivity. It can happen that a new technology is demonstrated to the men who are in a village while the women who actually would have benefitted most are out in the fields or gathering wood or water.

79. A lot of farms in Africa are run by women because their husbands have migrated to urban areas in a vain serch for better jobs, leaving their wives behind to run the farm and family by herself. A woman in this situation is all the more in need of means which alleviate the burdens she experiences in trying to produce enough food. Not only the husbands may have left for the cities, but also the young able-bodied men are often unable to escape the attraction of city life, thus depriving the farms of valuable labour.

Rural life no longer holds any charms for them. In Uganda, agricultural production has fallen because the youth are not available for farm work. 50/ "Reducing drudgery is important in retaining a commitment to farming by the young, and in releasing women and children particularly from the toil and tedium of many farming operations to spend their time more productively on other activities." 51/ Suitable technologies could help make farm work more profitable and less tedious, and, thus, more attractive for those youths and men who have a propensity to disappear to urban areas.

80. Since it is the women on small farms in Africa who have to do the most work, it is they who should be profiting most from better technologies. However, technologies can aggravate rather than eliminate social inequities, especially if motor-powered machinery is introduced. "Some researchers, observing the impact of technology on women, argue that, far from their being beneficiaries, the role of women can deteriorate as a result of farm mechanization. Men are often quicker to associate with machinery, leaving the unmechanized and most tedious jobs to women." 52/

81. Besides this argument against the introduction of machinery, there are others, such as the displacement of labour by engine-powered machinery in areas where there is un- or under-employment. "Improving hand or expanding animal systems is generally considered to have a gentle and mainly beneficial effect on employment and other socio-economic parameters". "... Inputs can be increased /through mechanization/... after a certain point, however, further mechanization begins to substitute for labour, particularly permanent hired labour." 53/ Nevertheless, appropriate technologies can also help overcome periodic labour shortages in areas where such problems become acute during certain seasons in the farming cycle where a lot of manpower is needed.

82. The question of equity arises not only between men and women, but also between poor farmers and those who are not so poor. Technology can aggravate the inequalities between richer and poorer farmers, 54/ as the richer ones may be able to afford certain types of technology, such as a low-cost diesel-powered water pump which significantly raises yield, while the poorer farmer has to do without.

83. The introduction of new technologies, such as better tools or improved varieties of plants, generally implies that more inputs external to the rural sector at the farm level are involved. This reduces the degree to which the farmers themselves are involved in the design and production of these technologies. This displacement of rural labour by a production process external to the small farmers in rural areas and the subsequent need to buy these implements and yield-raising inputs from the market is known as technology appropriation. This is a factor which needs to be taken into account when new technologies such as chemical fertilizers and ploughs are developed and introduced to small farmers in Africa. A further factor to be considered is technology substitution, which is the process by which industry is able to produce a substitute for a natural rural product with a comparative cost advantage, thus reducing or eliminating the traditional product's market share. As a result of technology appropriation and substitution, the rural farmer runs the risk of losing potential employment and income, and the agricultual sector is further marginalized. 55/

Traditions of Land Tenure

84. Traditions of land tenure can be an impediment to the introduction of certain innovations. Secure possession of land would give the farmers more incentive to attempt to improve their lot. This is particularly true with regard to long-term investments such as tree planting. A farmer who is not dependent on a higher authority for land allocation can plan further ahead, and planting trees needs longer-term planning and guaranteed access to the land for a long time. 56/

Access to Capital or Credit

85. Access to capital or credit is one of the biggest obstacles facing smallholders who want to acquire better technology. Usually they cannot afford to invest their meagre savings into something which carries a potential risk, and most banks and money-lending institutions do not lend money to farmers who do not have any collateral to show in return. Again, it is the poorest of the poor who have

the least access to credit, and, thus, are least able to pull themselves up by their bootstraps.

Pricing Policies

86. Pricing policies also have had an adverse effect on small farmers' productivity. A farmer who will not gain higher profits by producing and then selling more crops will have no incentive to do so. Often a farmer is forced to sell at harvest time and/or at fixed prices, which tend to be very low. "One of the major sources of failure has been the economic environment. Even where inputs were provided, farmers often had no real incentive to buy them or use them, because the prices they could get for their produce were not attractive... Low farm prices perpetuate no-input farming and the mining of the soil." 57/

Technology Policies

87. Technology policies also tended to ignore small-scale and intermediate technologies in favour of larger-scale and mechanized ones. The majority of the farmers were generally ignored, and technologies were expected to spread from the top down, rather than being developed in conjunction with the small farmers. "The policy instruments used have provided wrong signals and encouraged the transfer of inappropriate technologies. For example, price policies, comprising subsidies, tax concessions, unit pricing, overvalued exchange rates, etc., have favoured large against small producers, high-technology over intermediate/ appropriate stages, and urban consumers over rural producers." 58/

88. It is necessary that the intended beneficiaries of a new or improved technology are involved at all stages of planning and development. Solutions which are imposed from outside will be less welcome. If the community is involved it will develop a sense of responsibility towards the innovation and will not see it as something which is to be operated and maintained by outsiders. There may be nothing intrinsically wrong with the technology which is introduced from outside, but it might not be acceptable because the intended beneficiaries had not been involved in its development. "The high rate of non-adoption of the

technological innovations which have been introduced in the rural areas has been partly due to the failure to internalize the process of change in any community and the propensity of external forces to impose their own solution." 59/

89. In Africa, there are strong traditions of co-operation, and the small farmers often help each other by working on each others fields, or working together on one field, regardless of whom it belongs to. Therefore, once a technology has been accepted and adopted, it tends to have a demonstration effect. Other farmers will quickly notice that higher yields are being achieved thanks to this innovation and will either try to acquire it or arrange for it to be shared. This demonstration effect is very important in the dissemination of rural technology.

90. Factors such as land tenure, pricing policies and access to credit have a strong influence on people's acceptance or rejection of technologies. This naturally has a direct bearing on levels of productivity and must, therefore, be taken into account when discussing the role of technology in small farmers' productivity.

CONCLUSIONS AND RECOMMENDATIONS

91. Small farmers make up the majority of the population of African countries. Any policy aiming at the development of the continent must, therefore, necessarily focus on these citizens, who often also represent the poorest segment of the population, as well as those occupying the largest land area. Since their productivity is relatively low, there is great potential for improvement even with simple means. Assistance to small farmers helps alleviate poverty and is the only path towards the goal of national food self-sufficiency.

92. The land needs to be used more intensively "for by the year 2000, expansion of arable land can contribute only 25 per cent more food but increased cropping intensity and high yield varieties can give 75 per cent more." 60/ To achieve this end, governments must formulate coherent policies with regard to technology and food crop prices. Unfortunately,

intermediate technologies have often been neglected in favour of mechanization ("tractorization") in many African countries.

93. Farmers must be granted more attractive prices for their produce, and given better access to markets in order to give them an incentive to increase production. Access to credit would also have to be facilitated in order to give small farmers the means to acquire new tools and animals. Emphasis must be placed on food crops, more so than in the past, when cash crops were given the benefits of mechnization, fertilizers, etc., because they earned the country much-needed revenues.

94. Much emphasis has been placed on self-reliance in recent years in an attempt to cut down dependence on foreign technology, capital and other inputs. One step towards self-reliance would be for governmernts to formulate policies which promote indigenously produced intermediate technologies with the specific aim to increase food production at the initial stage. Attempts at introducing tractors have often failed, and so have top-down schemes of technology diffusion. It is time to place the new focus on the small food-producers and on the formulation of policies taking their needs into account, since these ultimately are also the needs of the entire nation.

95. The introduction of simple, low-cost and sustainable technologies should be seen as the first step towards self-reliance, food self-sufficiency and income generation. When a stage is reached where there is sufficient income to be able to afford more sophisticated machinery, this step can be taken, but the first step cannot be bypassed on the road towards development. There are signs that agricultural policies are being given the attention due to them by African governments, 61/ and these efforts need to be encouraged.

96. In conclusion, it must be emphasized that it is imperative that local conditions are taken into account when deciding on a technology policy this means that much research needs to be done at the level of the small farmer. As can be seen from th examples given in this paper, the potential for significant gains in productivity exist on

small farms in Africa, and the development of the region hinges on the improvement of the lives of the people who represent the majority of its population. It must be a step-by-step approach, because past failures have shown that the imposition of technologies from above has not been successful. The time to start with this development is now.

FOOTNOTES

1. OAU, Lagos Plan of Action for the Economic Development of Africa, 1980-2000, International Institute for Labour Studies, Geneva, 1981, p. 45.

2. See ECA, African Alternative Framework to Structural Adjustment Programmes for Socio-Economic Recovery and Transformation, ECA, Addis Ababa, 1989.

3. P. Crossley & J. Kilgour, Small Farm Mechanization for Developing Countries, John Wiley & Sons Ltd., Chichester, U.K., 1983.

4. See
   - R.J. Congdon, editor, Introduction to Appropriate Technology: Toward a Simpler Life-Style", Rodale Press Inc., Emmaus, Pennsylvania, 1977, pp. xiii-xiv and 25;
   - K. Darrow & R. Pam, Appropriate Technology Sourcebook, Volume One, Volunteers in Asia Inc., U.S.A., 1978, pp 11-12;
   - UNIDO Monographs on Appropriate Industrial Technology: No. 11, Appropriate Industrial Technology for Light Industries and Rural Workshops, United Nations, New York, 1979, p.11;
   - ECA, Appropriate Technology for African Women, United Nations, Addis Ababa, 1978, pp. 7-10. (Hereafter referred to as Appropriate Technology for African Women).

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